SEAC4RS Science Team Meeting
Boulder, CO April 15-18, 2014

A Preliminary Analysis of SEACIONS Ozonesondes from St. Louis, Missouri: August-September 2013

Joseph L. Wilkins[1], Gary A. Morris[2], Jack Fishman[1], and Benjamin de Foy[1]
[1]Saint Louis University , [2] Valparaiso University Contact Author: jwilkin9@slu.edu

Summary

32 ozonesondes were launched from Saint Louis, Missouri, from 8 Aug - 23 Sept 2013, as part of the **S**outh**E**ast **A**merican **C**onsortium for **I**ntensive **O**zone **N**etwork **S**tudy (**SEACIONS**) missions. Concurrent continuous ground level ozone measurements were made at Saint Louis University's St. Louis Ozone Garden in Forest Park. The SEACIONS summer deployment phase coincided with dual wildfires from Idaho's Beaver Creek (~115K acres) and California's RIM fire (~258k acres). In addition to the smoke from the fires; a frontal passage with a cut off low **[Aug 17-21]** led to ozonesonde profile changes resulting from **S**tratospheric-**T**roposphere **E**xchange (**STE**) and during a blocking high event **[Aug 26-30]** a mixed layer O3 enhancements can be spotted. Multiple satellite derived products and retrievals were used to analyze tropospheric pollution, fires, and air mass flow patterns. Trajectories from the launch site were ran by **Hy**brid **S**ingle **P**article **L**agrangian **I**ntegrated **T**rajectory (**HYSPLIT**) model to determine pollution plumes origins and transportation to other SEACION sites.

Methodology

- **Launch Radiosonde/Ozonesonde**
- **Search for interesting features**
- **Inspect meteorological situation**
- **HYSPLIT back trajectories, determine if features are present at multiple sites**
- **Use satellite and ground based datasets to determine plume origins.**

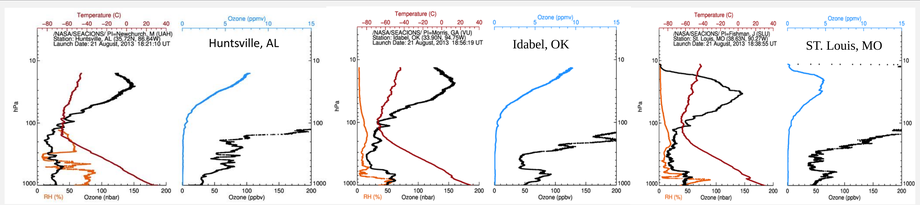
Saint Louis University Launch Team

Photo credit: Art Chimes – St. Louis Public Radio

Preliminary Results

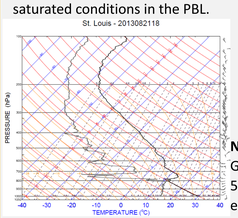
August 17-21 Case Cut Off Low [Day 21 shown]

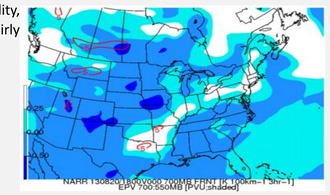
Summary: Convective instability exists across the region, with Upward vertical velocity values ~70m/s with a Cape of 2500 [Sqrt(Cape J/kg *2)] . A cutoff low was present in the middle [500mb 0817 06z – 0819 12z] and upper troposphere [300mb 0820 06z – 0822 00z] isolated from the main trough in the Westerlies. The greatest STE date was captured on the 20th at the STL site. The thermal tropopause drops from 15km on the 13th down to ~8km by the 20th. The thermal tropopause then returns by the 22nd to 15km. Evidence shows a lower level plume <5.0km stems from the Idaho and California fires.



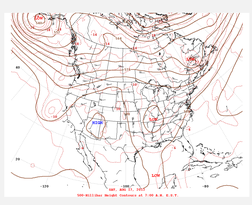
Ozonesondes: Surface plume 3.5km at Idabel and stl, ~4km at Huntsville. Polluted air appear to rise as it travels southeast. The STE causes O3 levels to rise to over 100ppb at 300hpa(~9km) level. Each figure displays on the left full profile and on the right tropospheric.

Sounding: Profile for convective instability, the mid-levels of the atmosphere are fairly dry with high dew points and near saturated conditions in the PBL.

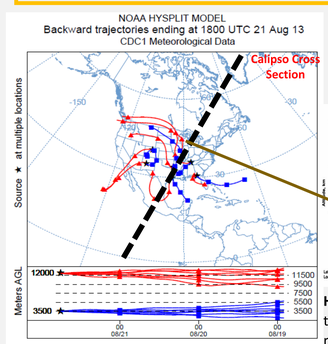




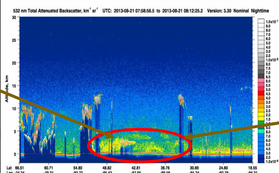
Met Situation: Image displays 500mb Cut off low on 0817 06z, The PVU map shows the areas of greatest chances for STE.



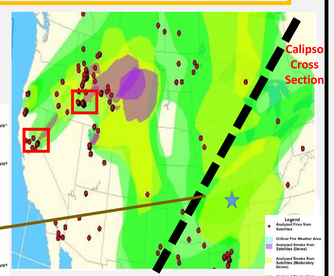
NARR DATA: Potential Vorticity Unit; Tropopause = 2 PVU; General tracers; stratospheric air high O3, low H2O, 315k 5.0PVU; tropospheric air low O3, high H2O, anthropogenic; emissions (e.g., CO, CFCs, …) 295k 0.5PVU



CALIPSO track cross section: traces across the central US, and captures the smoke plume present in the mixed layer at our site. **(red circle)**



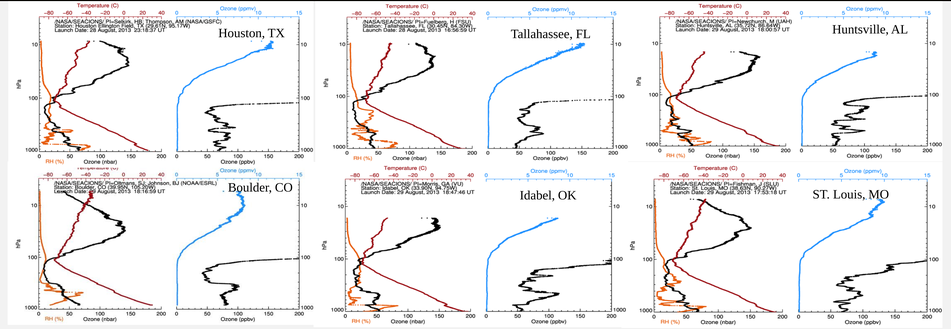
HYSPLIT: 3 day back trajectories, depicting the center of the lower plume[2-5km] and remnant STE [11-15km]



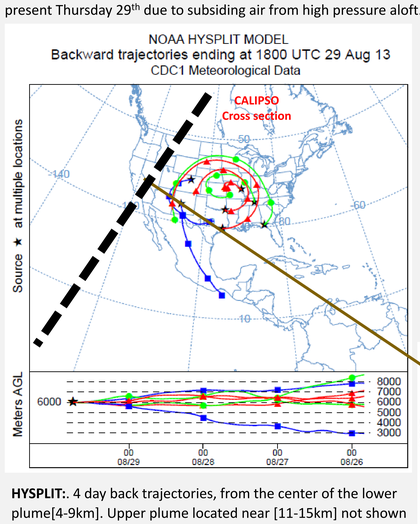
Hazard Mapping System Fire and Smoke Product AUG16: Displays the California RIM fire and Idaho Beaver Creek fire **Red Box,** Star is STL location.

August 26-30 Case Stagnant Air [Day 29 shown]

Summary: By Saturday 24th, Smoke from the two wildfires covered two thirds of the continental US. A Blocking High pressure system moves in on Monday 26th 18Z swirling warm dry polluted air around Southeastern US. The blocking high kept additional pollution to the north, Tuesday 27th and Wednesday 28th, until a frontal approach on Thursday 29th weakened the core pushing it westward by Friday 30th 12Z and allowed smoke from the fires to reenter the southeastern US. HYSPLIT trajectories during the week exhibit a spiral centered on STL location with dirty dry air going down and cleaner moist air going up. A double plume feature is present at every site except Socorro, NM with Boulder, CO only receiving lower plume.

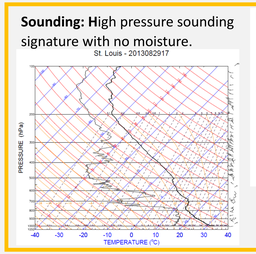


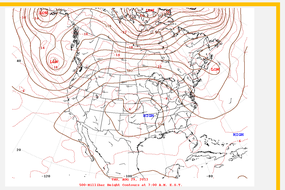
Ozonesondes: Double plume feature: *Lower Plume:* Dry polluted air enhanced by high pressure system, appears to be coming from Oklahoma, Kansas area and as far west as Colorado. *Upper Plume:* Moist polluted air from the California RIM FIRE and Idaho Beaver Creek fire. A brief STE is present Thursday 29th due to subsiding air from high pressure aloft.



HYSPLIT:. 4 day back trajectories, from the center of the lower plume[4-9km]. Upper plume located near [11-15km] not shown

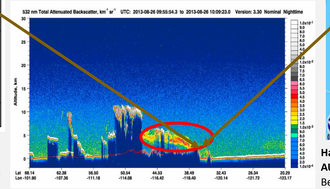
Sounding: High pressure sounding signature with no moisture.





MET Situation: High pressure on Thursday Aug. 29 12Z. Similar feature remains constant the entire week.

CALIPSO track cross section: Captures smoke and dust pollution from the California RIM **fire (red circle),** with its plume directed northbound towards Oregon border.

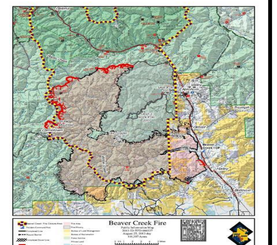


Hazard Mapping System Fire and Smoke Product AUG24: Displays the California RIM fire and Idaho Beaver Creek fire in red box. Star is STL location

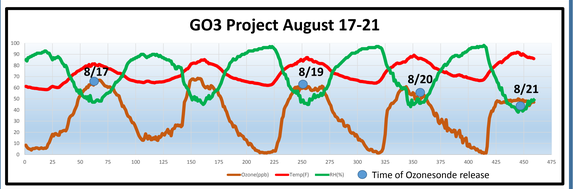
Fires/Plume Sources

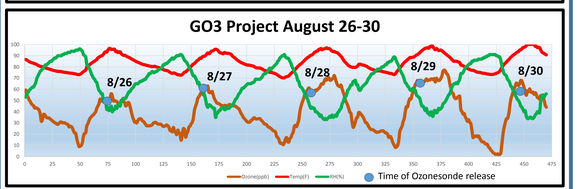
California RIM Fire 257,314 acres
[Aug 17th] (37 51' N, 120 05' W)
Cause: Illegal Camp Fire

Idaho Beaver Creek 114,900 acres
[Aug 7th] (43 98' N, 112 23' W)
Cause: Lightening strike



St. Louis Ozone Garden





Ground level ozone measurements were made at the Saint Louis University's St. Louis Ozone Garden in Forest Park. Allowing for verification of ozonesonde measurements prior to launch. Relative Humidity(%) [negative correlation], Temperature (F) [positive correlation] and Ozone(ppb) are shown. **On the x-axis every 25 = 6hours since start date.

Future Work

- **FLEXPART-WRF: Forward and Backward Trajectories**
- **Box model of the chemical evolution of the plume**
- **Impacts of Frontal Passage on ozone profile**
- **Compare vertical profiles with OMI retrievals**
- **Interactions of Urban Pollution with convection**

Acknowledgements

This work was supported in part from NASA Grant NNX11AJ63G to Saint Louis University through its AQAST Program.